Evaluation of Meteorologically Adjusted Air Quality Trends in Ohio

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Summary

Background

Over the last decade there has been increased attention on the potential health impacts of several air pollutants such as ozone, particulate matter, carbon dioxide, sulfur dioxide, and nitrogen dioxide. The State of Ohio has made continuous efforts to reduce major air pollutant levels to comply with the changing national ambient air quality standards (NAAQS). Air quality problems in Ohio are associated with both local emission sources and pollutants transported over great distances. Industrial and urban activities in Ohio contribute to local and regional air pollution problems. Most of the major industrial sources of air pollutant precursors are located in the Ohio River Valley. Meteorological conditions also contribute to the formation and transport of pollutants within Ohio. A detailed understanding of long-term trends, the sources of pollutants, their precursors, and meteorological conditions affecting ambient concentrations is required for any meaningful air quality planning in Ohio.

Objectives/Methodology

In this study a retrospective analysis of air pollutants in urban and suburban areas in Ohio was conducted for the years 1992 through 2000. The analysis included air quality and meteorological data obtained from monitoring sites operated by the local air agencies and Ohio EPA, in Cincinnati, Dayton, Toledo, Columbus, Cleveland, Akron, Marietta, and Steubenville. The retrospective analysis involved the following:

1. Statistical analysis.

- General characterization of ozone (O_3), particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) was performed using time-series analysis for high pollution days. Time-series values used for this analysis were; 1) 1-hour and 8-hour averaged concentration values for O_3 and CO, 2) 1-hour and 24-hour averaged concentration values for PM, and 3) 8-hour averaged concentration for SO_2, and NO_2. For this retrospective analysis high pollutant episodes were identified and analyzed.
- Kolmogorov-Zurbenko (KZ) filter analysis was used to evaluate trends, variance, and long-term, short-term, and seasonal components for the pollutant concentrations.
- Statistical analysis of monthly, weekly, and hourly distributions was conducted.

- The air quality data obtained for the selected sites located in urban and suburban areas in Ohio were analyzed using correlation techniques to identify spatial relationships.

2. Meteorological Analysis.

- Correlation analysis was completed to evaluate the impact of temperature, wind direction, wind speed, and humidity on ambient pollutant concentrations.
- Meteorological evaluations included back trajectory and cluster analysis to identify atmospheric patterns associated with the transport of air pollutants from source regions.

Results/Conclusions

The study evaluated the trends, seasonal and spatial patterns, and the meteorological influence on air pollutants in Ohio for the years 1992-2000. A summary of the major conclusions of this study include:

1. The 8-hour averaged O_3 and NO_2 concentrations have increased from 1992 through 2000. For CO, SO_2, and PM less than 10 μm (PM_{10}) a decrease in the long term trends was experienced.

2. In comparison to the rest of the week Saturday and Sunday had the highest frequency of high ozone days, as defined by the 8-hour standard, for a majority of the metropolitan areas in Ohio.

3. The back trajectory/cluster analysis indicates that the Ohio River Valley is a major source region for ozone and PM_{10}.

4. In addition the back trajectory/cluster analysis identified source regions corresponding with major urban and industrial regions in neighboring states including Detroit, Chicago, and Indianapolis for O_3 and PM_{10}.